

CLAIMS

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1. A polarized display device having an expanded angle of illumination for optimizing a viewing angle in a desired plane comprising:
  - a polarized display panel; and
  - a polarization rotating element proximate to a surface of the polarized display panel, wherein said polarization rotating element rotates light polarization between a first polarization orientation and a second polarization orientation.
2. The polarized display device of claim 1 wherein said first polarization orientation comprises an incoming orientation and said second polarization orientation comprises an outgoing orientation.
3. The polarized display device of claim 2 wherein said incoming orientation comprises a rear element pass axis and said outgoing orientation comprises a rear polarizer pass axis.
4. The polarized display device of claim 1 wherein said polarization rotating element is index matched to the polarized display panel.

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5. The polarized display device of claim 1 wherein the first polarization is aligned with a major axis of a desired viewing envelope.

6. The polarized display device of claim 1 wherein said polarization 5 rotating element is located in front of the polarized display panel.

7. The polarized display device of claim 1 wherein said polarization rotating element is located to a rear of the polarized display panel.

10 8. The polarized display device of claim 1 further comprising an optical element adjacent to a first side of said polarization rotating element and the polarized display panel adjacent to a second side of said polarization rotating element.

15 9. The polarized display device of claim 8 wherein the optical element has polarization-sensitive asymmetric transmittance characteristics related to Brewster angle effects.

10. The polarized display device of claim 8 wherein the optical 20 element has a polarization axis.

11. The polarized display device of claim 10 wherein the optical element comprises a polarization sensitive scattering element.

12. The polarized display device of claim 1 wherein the polarization rotating element comprises a member from the group consisting of a retarder, a halfwave retarder, a multilayer retarder and a twisted optical axis element.

5 13. The polarized display device of claim 1 wherein the viewing angle  
has an angle within a range of 25° to 60° from normal.

14. The polarized display device of claim 1 further comprising front and rear polarizing filters and wherein the polarized display panel comprises a polarization modular situated between front and rear polarizing filters, and wherein said polarization rotating element is situated external to a region between said front and rear polarizing filters.

15. The polarized display device of claim 1 wherein the polarized  
15 display panel is an active matrix liquid crystal display.

16. The polarized display device of claim 8 wherein the optical element is an optical film.

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17. An apparatus for improving the viewability characteristics of a polarized display panel comprising:

a polarization sensitive scattering element having a first polarization axis; and

5 a polarization rotating element attached to one surface of the polarization sensitive scattering element.

18. The invention of claim 17 wherein said polarization rotating element is proximate to the polarized display panel, and a polarization axis of 10 said polarization sensitive scattering element is oriented such that a major axis of a transmittance envelope associated with said polarization sensitive scattering element is oriented along a desired viewing angle.

19. A method of projecting light using a polarized display, the method 15 comprising the steps of:

transmitting light from a rear optical element in an asymmetric angular pattern for a first polarization and having a transmittance envelope with a major axis for the first polarization;

receiving light by a polarization rotating element from said rear 20 optical element in the first polarization;

rotating light to a second polarization by the polarization rotating element; and

receiving light from the polarization rotating element in the second polarization by a polarized display panel having a rear polarizer.

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20. The method of claim 19 further comprising the step of selecting a range of angles to be optimized.

5 21. The method of claim of claim 20 wherein the step of selecting a range of angles comprises selecting a material for the polarization rotating element that corresponds with the selected angle.

10 22. The method of claim 21 wherein the step of selecting a material comprises selecting a material with predetermined retardances and angles.

15 23. A polarized display device comprising:  
a rear optical element transmitting light in a pattern and having a first polarization;  
a polarized display pane having a rear polarizer oriented to receive light from the rear optical element in the first polarization and transmit light in a second polarization; and  
a polarization rotating element receiving light from the polarized display pane in the second polarization, rotating the light to a third polarization,  
20 and transmitting the light.

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24. The polarized display device of claim 23 wherein the pattern of light transmitted by the rear optical element has a major axis and a minor axis, the major axis being aligned with the pass axis of the polarized display panel and being significantly broader than the minor axis.